RESEARCH NOTES

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PROGRESS REPORT ON THE RATE OF DETERIORATION OF BEETLE-KILLED ENGELMANN SPRUCE IN COLORADO

by

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A severe windstorm in 1939 blew down extensive patches of Engelmann spruce (Picea engelmannii Parry) in western Colorado. A major epidemic of the Engelmann spruce beetle (Dendroctonus engelmanni Hopk.) developed from the windthrown trees and by 1952, when the epidemic was controlled by a combination of chemical and natural-control factors, an estimated four billion board-feet of Engelmann spruce and a half billion board-feet of lodgepole pine had been killed. 2/

This great volume of dead timber presents a major salvage problem. Since it was not possible to utilize this material immediately after it was killed, the question arises as to how much will be salvable as time passes. Mielke reports that the rate of deterioration of Engelmann spruce is relatively slow. 3/ He studied a stand in southern Utah where this beetle had killed all the merchantable Engelmann spruce 25 years before, and estimated that 84 percent of the trees were still standing. He also found that decay in standing trees was negligible except for occasional basal sap rot.

1/ The authors gratefully acknowledge the assistance of Ross W. Davidson, Beltsville Forest Disease Laboratory, in identifying numerous decay fungi.

2/ Nelson, Arthur L. Control and salvage policy: spruce beetle control in Colorado. Jour. Forestry 52: 503-505. 1954.

3/ Mielke, James L. Rate of deterioration of beetle-killed Engelmann spruce. Jour. Forestry 48: 882-888, illus. 1950.

In 1951, a study[4/] was begun to determine the rate of windfall and extent of decay in standing dead trees in the beetle-killed Engelmann spruce stands in Colorado.

METHODS

The four study areas on the White River and Routt National Forests used for these investigations are described in table 1. Areas were selected to obtain a range in time since the period of peak beetle activity. In each study area, 25 circular 1/10- or 1/20-acre plots were established at 3-chain intervals along grid lines. The plan of the study was to fell and dissect all the standing trees on 5 plots in each study area in 1951 and at 5-year intervals until 1971 to determine the prevalence of decay in standing dead trees. The uncut plots are examined at 2-year intervals to record the number of trees which are windthrown.

Table 1. --Description of the four study areas

Study area	Estimated peak year of mortality[1]	Aspect	Killed Engelmann spruce (1951)	
			Average age	Average d.b.h.
			Years	Inches
Routt National Forest:				
Walton Creek	1949	NE slope	165	14
White River National Forest:				
Pyramid	1941	Level	260	17
101 Ranch	1946	NE slope	243	14
Deep Creek	1944	NW slope	100	14

[1] The year of peak mortality was determined either from persons familiar with the particular areas or by dating attacks in recovered trees.

4/ Gill, Lake S. Progress report 1: Colorado spruce deterioration study. U. S. Bur. Plant Indus. Div. Forest Path., 5 pp. February 13, 1952. [Typewritten report.]

RESULTS

WINDFALL

A summary of the proportion of the gross cubic-foot volume in trees down since the plots were established is given in figure 1. Four counts at 2-year intervals were made on the 15 uncut plots in each area. A trend line based on the rates of windfall in the 4 areas indicates that an average of about 17 percent of the original gross cubic-foot volume will be down in 15 years (fig. 1). Windfall on a tree basis was essentially the same and amounted to 16 percent in 15 years. This period approximates the length of time since the peak of the bark beetle activity on the White River Plateau (1943-46).[5/] There was considerable variation in the rate of windfall in the four study areas. For example, on the 101 Ranch plots, 23 percent of the volume was down in 11 years, while in the Deep Creek area only 9 percent was down after 13 years. It is not known how much of this variation is due to local site conditions, to differences in length of the time of beetle activity, or to errors in estimating the peak year of beetle activity in each area.

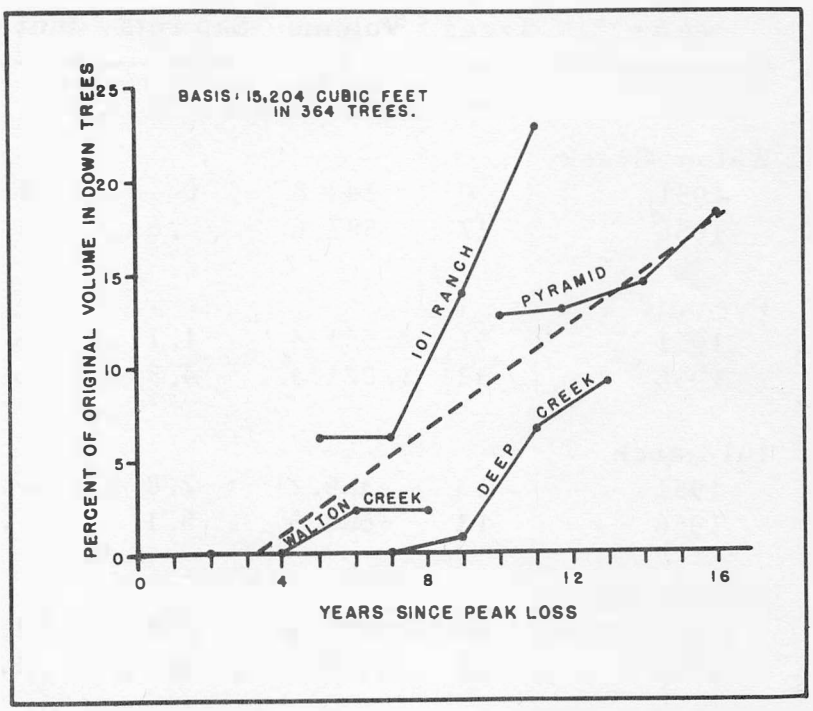

Figure 1. -- Cubic-foot volume in trees windthrown in relation to time since peak attack. Dotted line is average for all areas.

5/ Knight, F. B., and McCambridge, W. F. Engelmann spruce beetle conditions: Routt, Arapaho, and White River National Forests, Colorado. U. S. Bur. Ent. & Plant Quar. Div. Forest Insect Invest., Ft. Collins, Colo., 18 pp., 1952. [Unpublished report.]

DECAY IN STANDING DEAD TREES

All the trees on 5 plots in each study area were felled and dissected in 1951, and 5 more on each area were clear cut in 1956. A summary of the number of trees cut and the decay volumes in each area is shown in table 2. All the sap rot losses have occurred since the trees were killed; hence, some heartrot probably existed while they were still living. The small size of the sample, plus the fact that the first examinations were made on areas where the time of peak beetle attack varied from 2 to 10 years, precludes an estimate of heartrot volume before death. Since it appears that heartrots have continued to develop in dead trees, they have been included as a deterioration factor. The trends therefore show in effect the losses in gross volume since the beetle outbreak, plus a small undetermined amount prior to that time.

Table 2. --Extent of decay in dead standing trees in 1951 and 1956

Area and year	Basis		Decay			
	Trees	Volume	Sap rots	Butt rots	Trunk rots	All rots
	No.	Cu. ft.	Percent			
Walton Creek						
1951	9	244.8	0	1.4	0	1.4
1956	27	587.6	.6	1.7	6.4	8.7
Pyramid						
1951	51	2,551.4	1.7	4.9	4.1	10.7
1956	32	1,021.4	4.5	5.3	3.8	13.6
101 Ranch						
1951	12	369.2	2.8	.5	0	3.3
1956	13	682.5	5.1	.3	.6	6.0
Deep Creek						
1951	50	1,774.6	4.8	1.5	1.0	7.3
1956	38	1,380.1	4.7	1.2	15.2	21.1
All areas						
1951	122	4,940.0	2.8	3.1	2.5	8.4
1956	110	3,671.6	4.1	2.2	7.9	14.2

The average amount of decay on each study area in 1951 and 1956 is shown in figure 2. A trend line based on the amount of rot in the 4 areas suggests that decay in these averaged 11 percent 10 years after the date of peak mortality and 17 percent after 15 years.

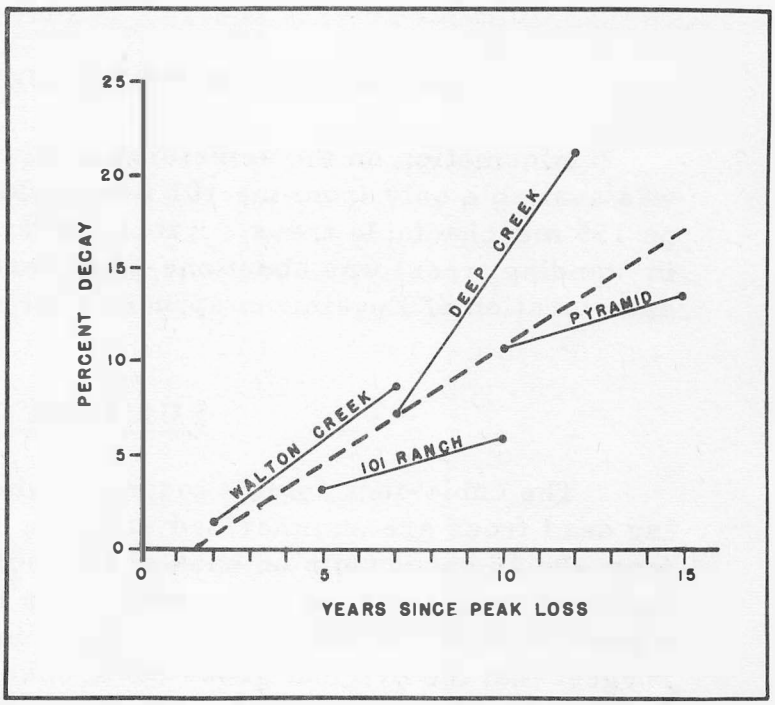

Figure 2. --Amount of decay in dead standing trees in each study area in 1951 and 1956 (cubic-foot basis). Dotted line shows average trend.

Decay in each study area increased between 1951 and 1956 (table 2), but there was no consistent increase in the various types of decays (sap rots, butt rots, and trunk rots).[6/] For example, most of the greater decay volume in 1956 on the Walton Creek and Deep Creek plots was due to trunk rots, but sap rots accounted for most of the increase on the Pyramid and 101 Ranch plots. The average for all areas indicates little difference in the proportion of butt and sap rots from 1951 to 1956, but the proportion of trunk rots was 3 times as great in the same 5-year period.

On the basis of average decay volumes from the 1951 and 1956 dissection work, Fomes pini (Thore) Lloyd was the most important fungus and it caused about 42 percent of all decay. The brown trunk rot fungus, Stereum sanguinolentum A. & S., accounted for about 10 percent of the total decay volume. About half of the butt rot was caused by Fomes nigrolimitatus (Romell) Egel., and decay by this fungus amounted to about 15 percent of the total rot. These three fungi are common heartrot fungi in living trees and continue to

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6/ Sap rots are decays that begin at the outside of the trunk and progress inward. Butt rots are heartrots which begin near the ground level and work upward. Trunk rots are heartrots higher in the bole.

develop in killed trees. Fomes pinicola (Swartz) Cke., which causes a brown cubical rot, was the most prevalent sap rot fungus and was responsible for about two-thirds of all sap rot and about 15 percent of all decay.

DETERIORATION OF LODGEPOLE PINE

Information on the deterioration of beetle-killed lodgepole pine was available only from the 101 Ranch plots. Measurements were made on 155 merchantable trees. Rate of deterioration (windthrow plus decay in standing trees) was about one-third less than the average rate of deterioration of Engelmann spruce in all areas.

SUMMARY

The cubic-foot volume losses to windthrow and to decay in standing dead trees are summarized in figure 3. The windthrow data are from the 15 uncut plots on each of the four study areas. The data on decay in standing trees were obtained by felling and dissecting trees on 5 plots in each area in 1951 and 5 more in 1956. The results of the study suggest that the original gross cubic-foot volume in these areas will be reduced by 34 percent after 15 years from the time of peak beetle activity. The loss is about equally divided between windthrow and decay in standing trees. Because of the variation of decay and windthrow in the different areas, no attempt was made to estimate the future rate of deterioration in these stands.

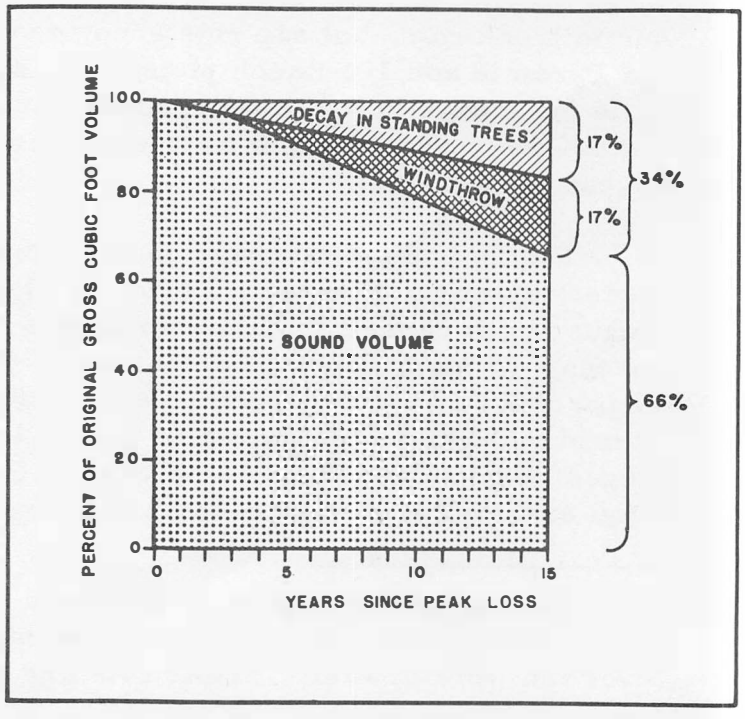

Figure 3. --Summary of cubic-foot losses due to windthrow and decay in standing trees in relation to time since peak attack.